

Reticle schematic

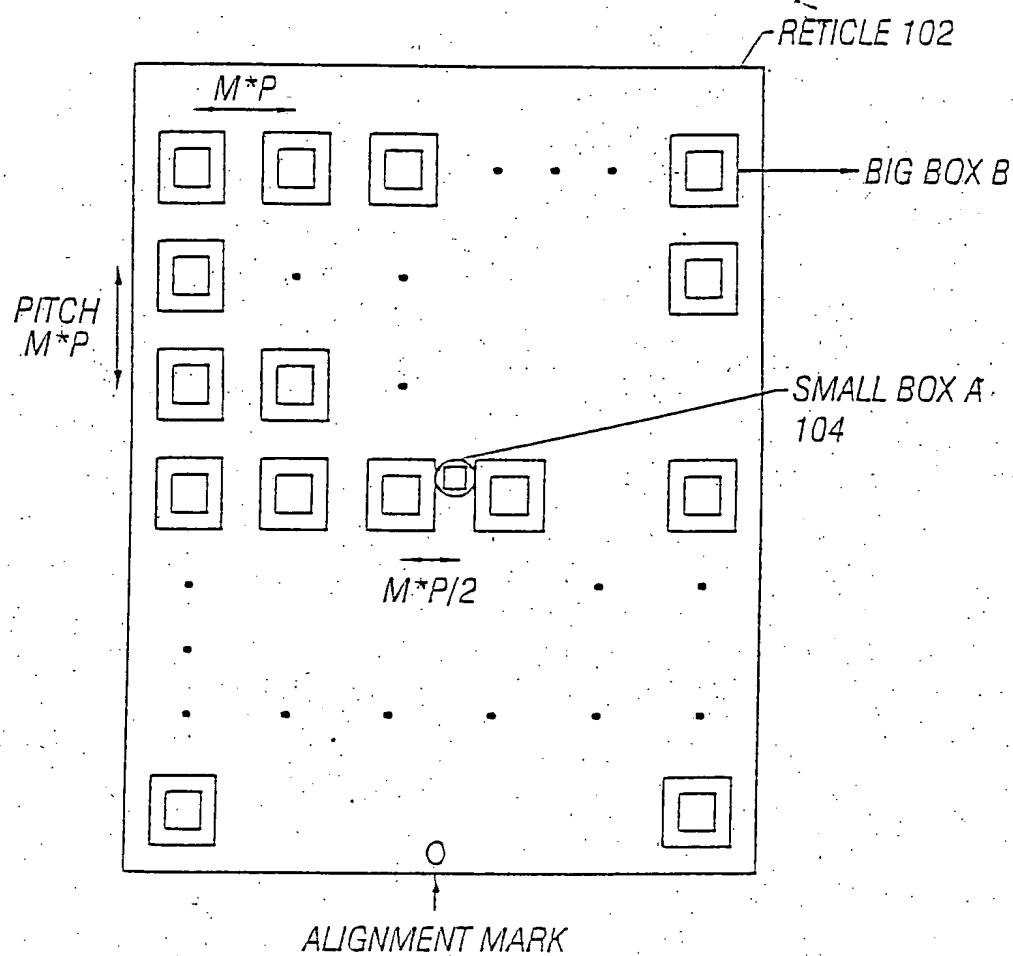


FIG. 1

Schematics for FIG. 1

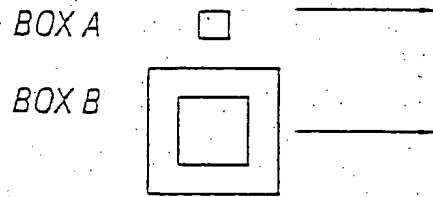


FIG. 2

Reticle Features

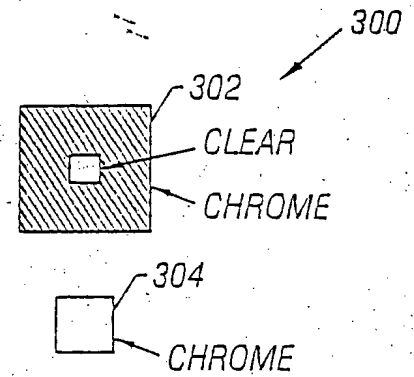


FIG. 3

Overlapping regions

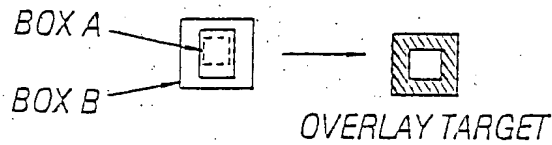


FIG. 4

*Perfectly centered
Box-in-Box structure*

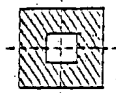


FIG. 4A

Schematic for outer box 2



FIG. 5

Outer box 2 as printed on wafer.
 Dark=unexposed, white=exposed

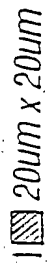


FIG. 6

Schematic for inner box 1



FIG. 7

Inner box 1 as printed on wafer.
 Dark=unexposed, white=exposed

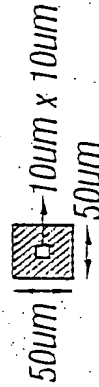


FIG. 8

Schematic for 2-dimensional 4XOL reticle

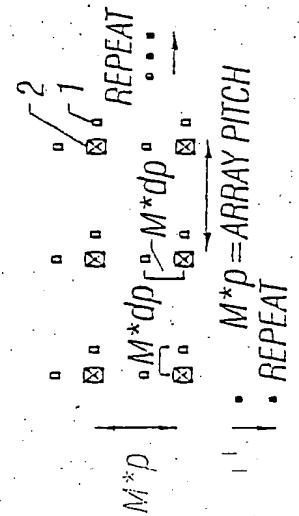


FIG. 9

Typical 4XOL reticle overlay set as projected
 onto wafer (3 featured parts); dark=unexposed,
 white=exposed

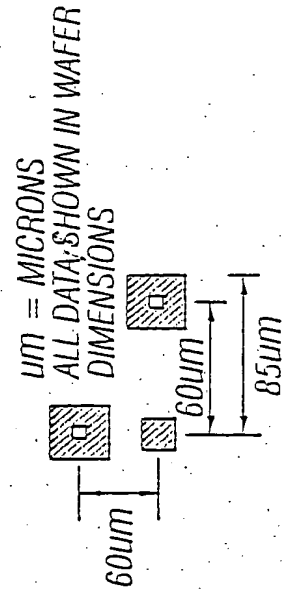


FIG. 10

Schematic of X-shear overlay on wafer

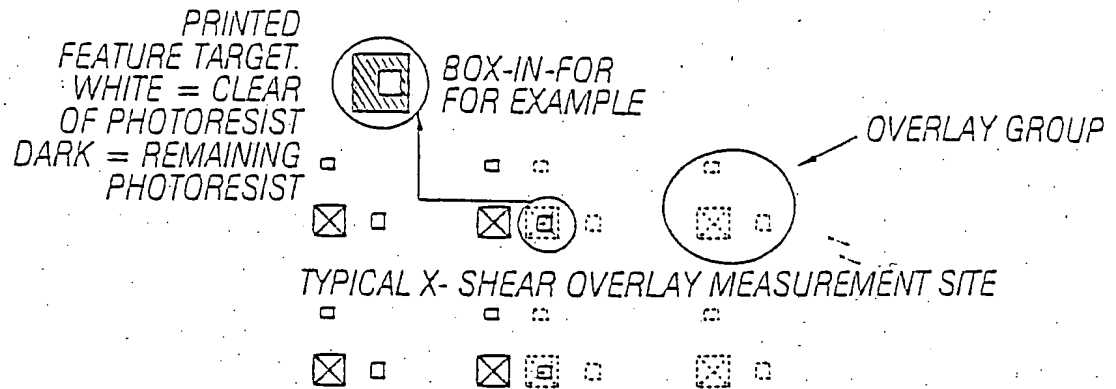


FIG. 11

Schematic of Y-shear overlay on wafer

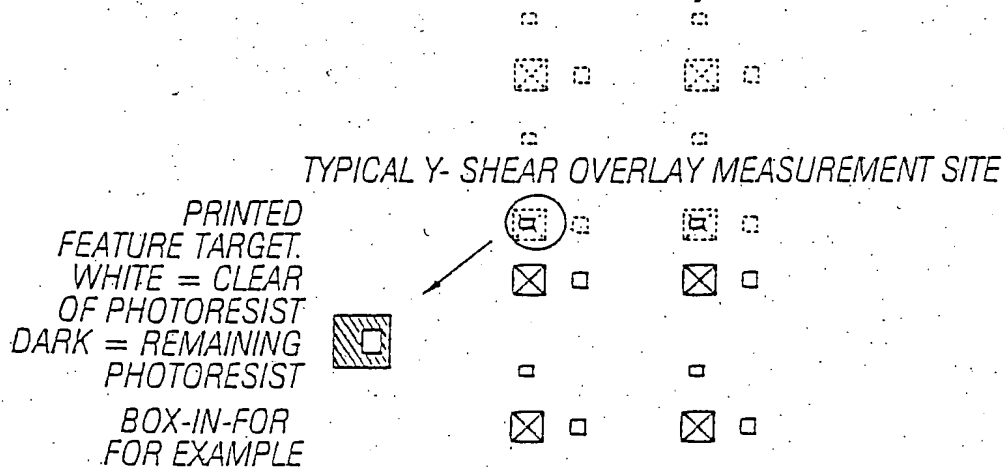


FIG. 12

2-Dimensional reticle schematic, 90 degree overlay or R-shear.

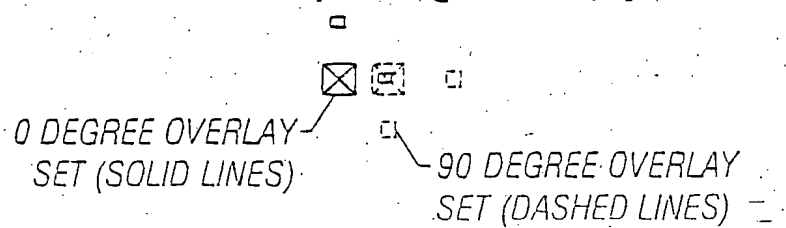


FIG. 13

Typical overlay patterns or completed alignment attributes

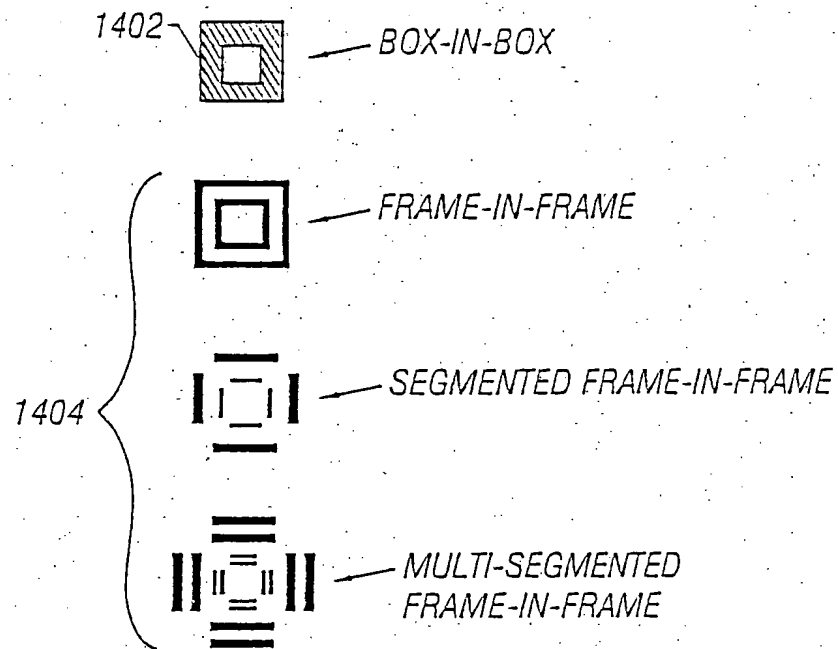


FIG. 14

*Process-flow for the second embodiment for self-referencing
 lens distortion measurement.*

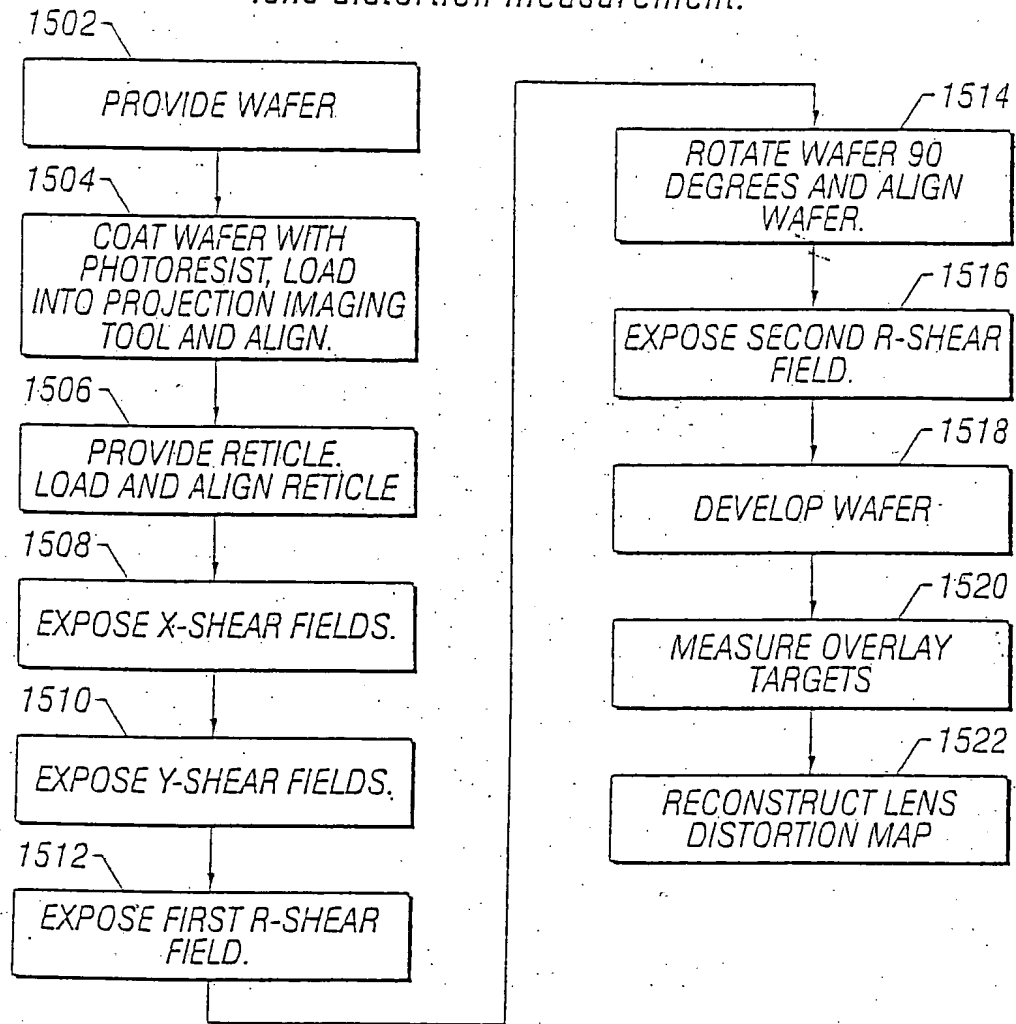
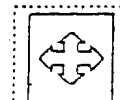
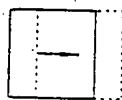


FIG. 15

*Some components of overlay or placement error
 (Inter-field and Intra-field)*



TRANSLATION ROTATION NON-ORTHOGONALITY SCALE OR MAGNIFICATION

FIG. 16

Photolithographic stepper or scanner system

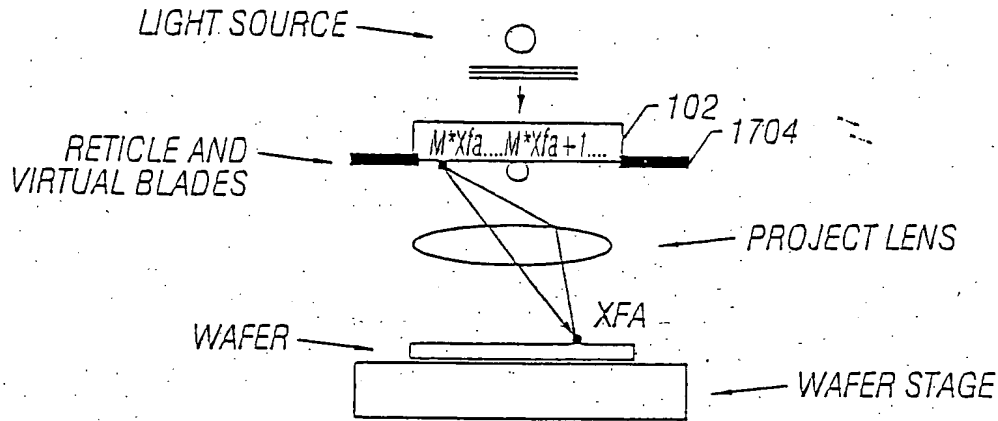


FIG. 17

Intra-field overlay error

Inter-field overlay error

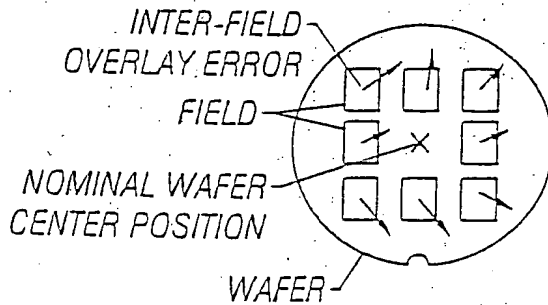


FIG. 18

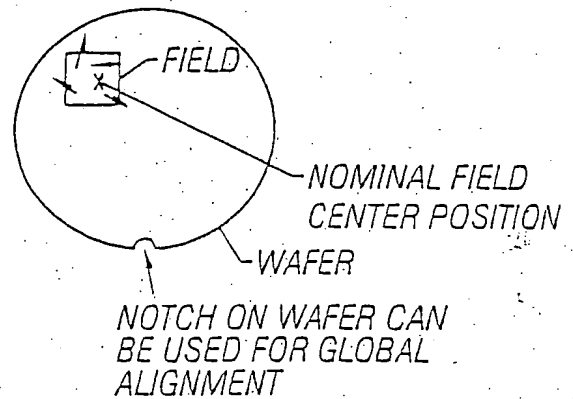


FIG. 19

New Overlay reticle

RETICLE 2002-20A

[illegible]

FIG. 20

Typical Detail of overlay group on New Overlay reticle (FIG. 20) as used on an M=4 lithographic projection tool. Dark=chrome, white=open

$\mu m = \text{MICRONS}$

ALL DATA SHOWN AT RETICLE

- 4*50um x 4*50um WITH

4*10um x 4*10um INNER HOLE

 $4 \times 60 \text{ min}$ $4 \times 60 \mu m$

4*85 um

4*20um x 4*20um

FIG. 20A

Intra-field indices projected onto the wafer

*Side view of reticle of
 FIG. 20*

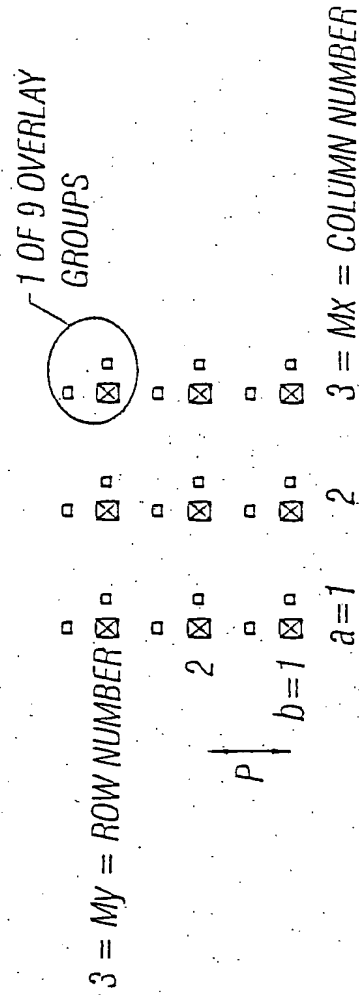
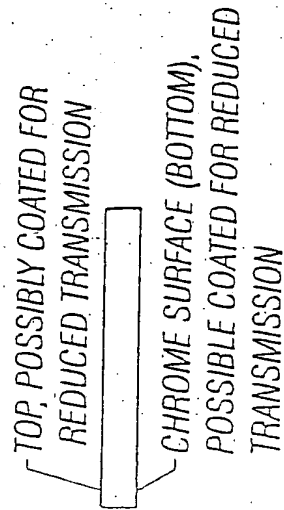


FIG. 20C

FIG. 20B

Example of prior art lens distortion test

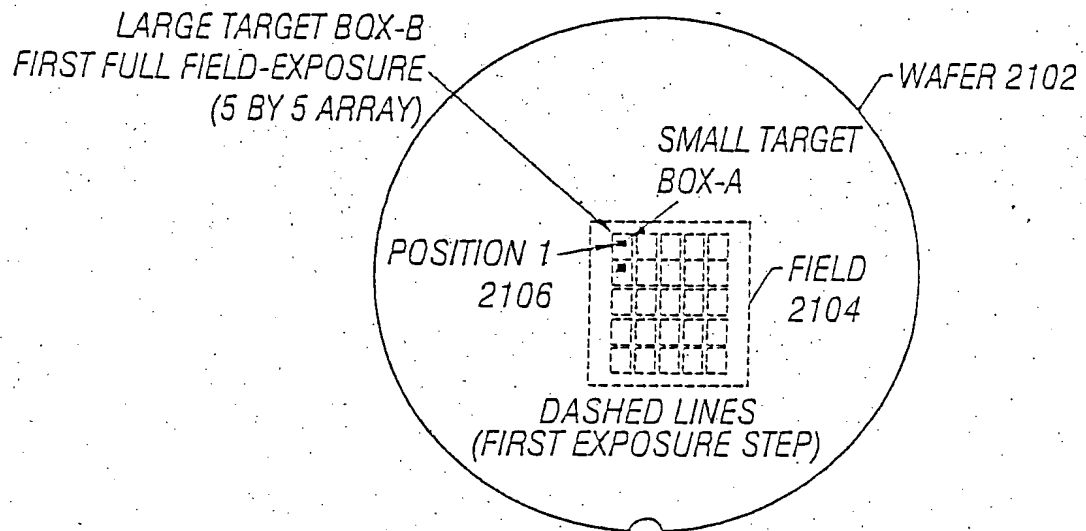


FIG. 21
(Prior Art)

Wafer with alignment marks at 0 and 90 degrees

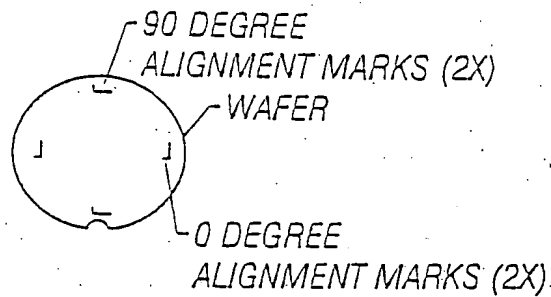


FIG. 22

Wafer after exposure of FIG. 20 overlay reticle at the 0 degree orientation

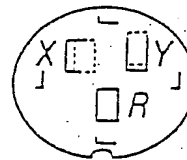


FIG. 23

Wafer after exposure of FIG. 20 overlay reticle at the 0 and 90 degree orientations (clockwise)

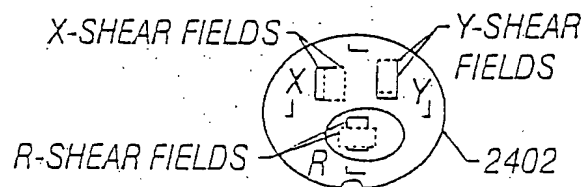


FIG. 24

Detail of R-shear pattern on wafer

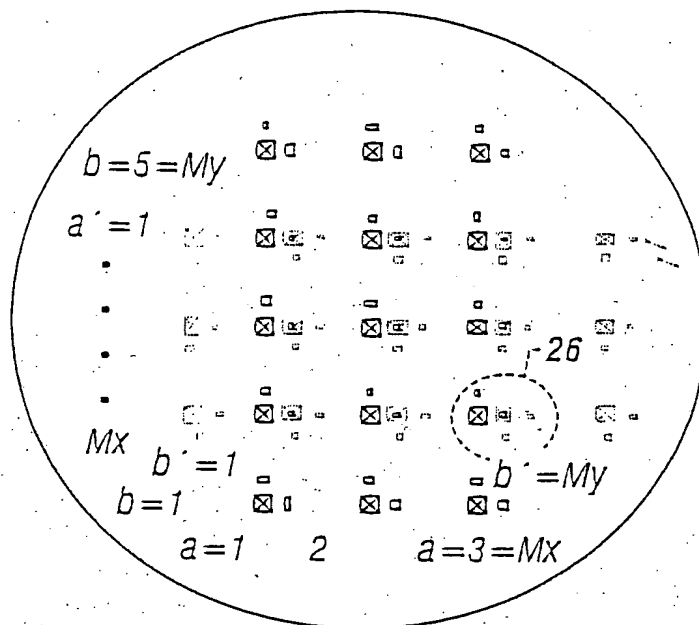


FIG. 25

Closeup of overlay groups for R-shear

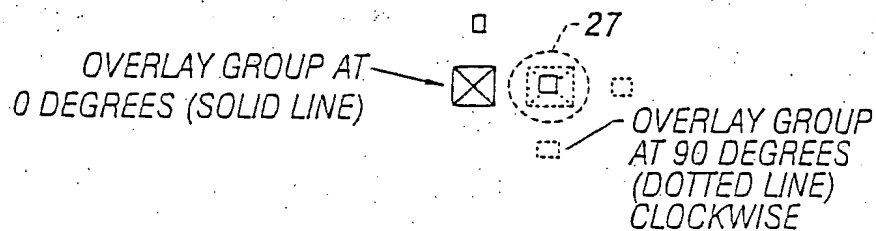


FIG. 26

*Single Box-in-Box target.
 dark = undeveloped photoresist
 white = no photoresist*

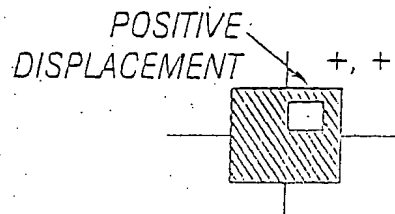


FIG. 27

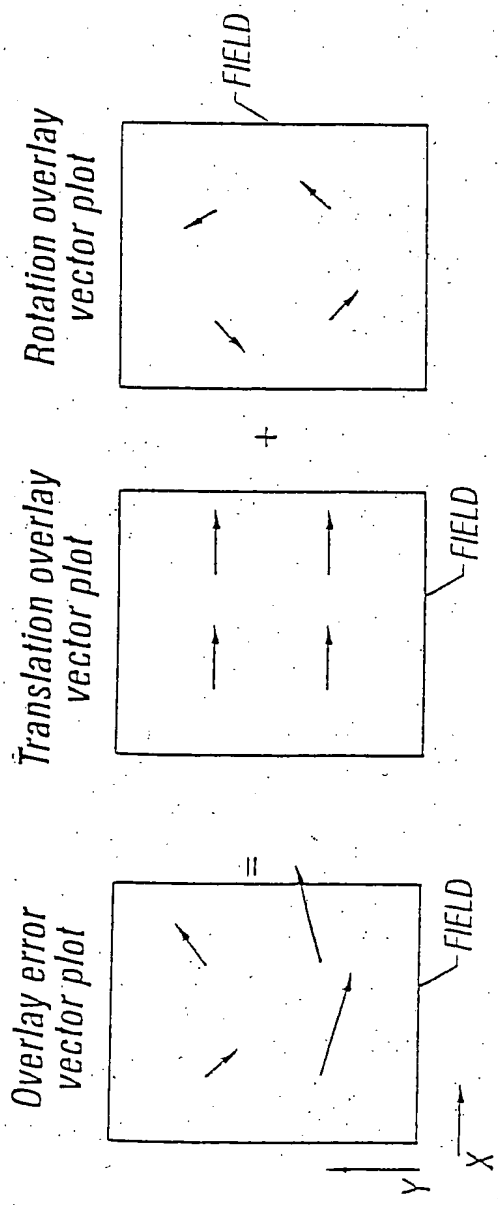


FIG. 28 FIG. 29 FIG. 30

Overlay measurement

THE VECTOR REPRESENTS THE ALIGNMENT
 OFFSET DISTANCE BETWEEN THE BOX-IN-BOX
 STRUCTURE

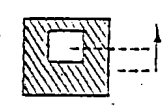
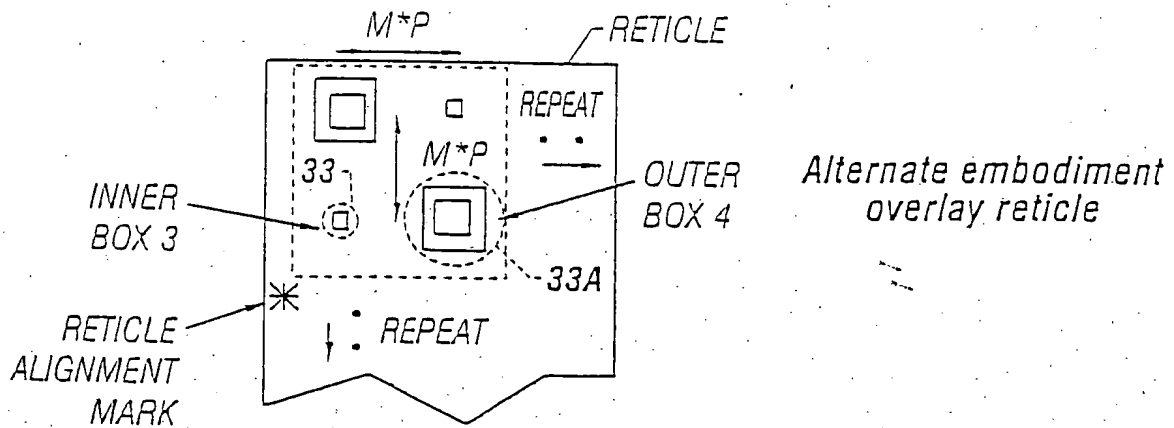


FIG. 31



Inner box 3 on reticle.
 Dark=chrome,
 white=open.

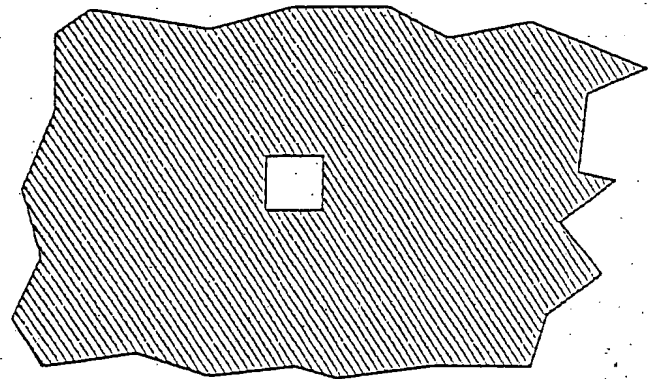
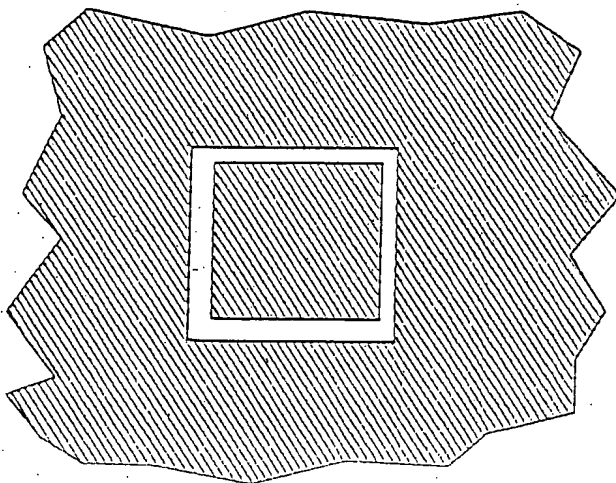


FIG. 33



Outer box 4 on reticle.
 Dark=chrome,
 white=open.

FIG. 33A

*Process flow for the preferred
embodiment for self-referencing
lens distortion measurement.*

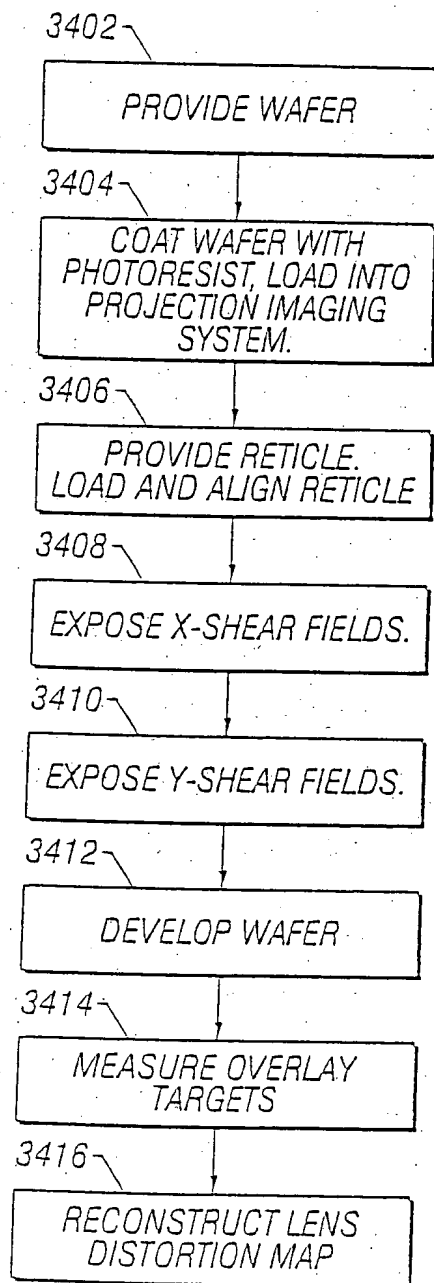


FIG. 34

*Process flow for the alternate
embodiment utilizing sub-Eo
exposure doses on the wafer.*

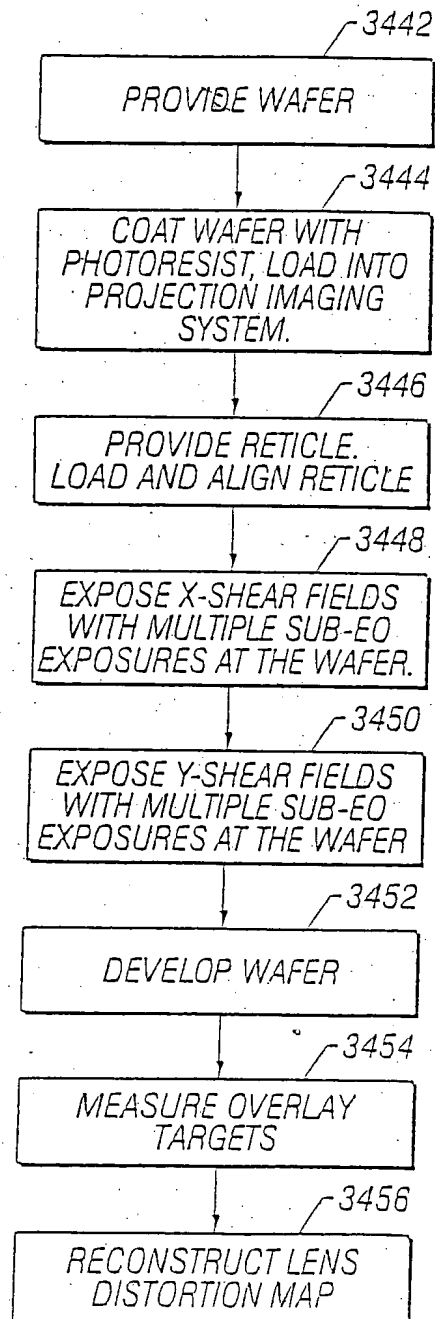
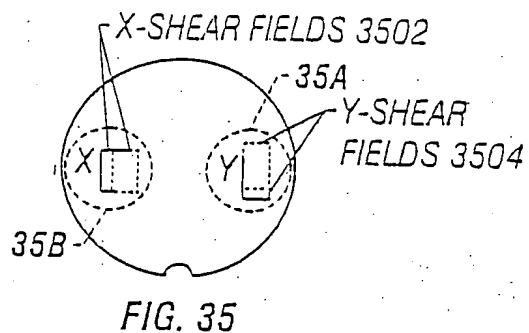


FIG. 34A



Wafer after exposure of
 FIG. 20 overlay reticle for
 X and Y shears.

Detail of Y-shear for a 2 x 2
 set of overlay groups

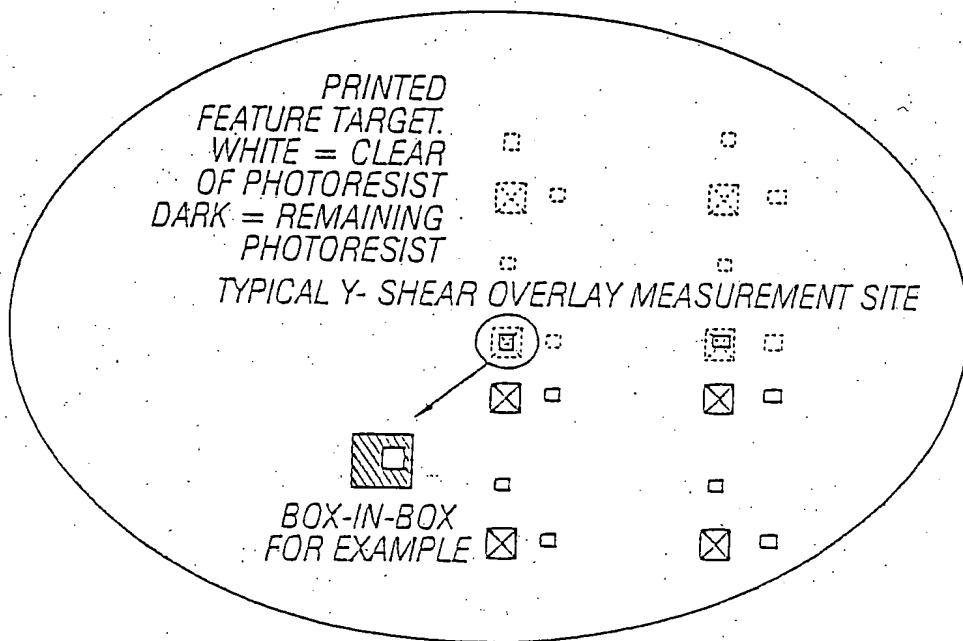


FIG. 35A

*Detail of X-shear for a 2 x 2
 set of overlay groups:*

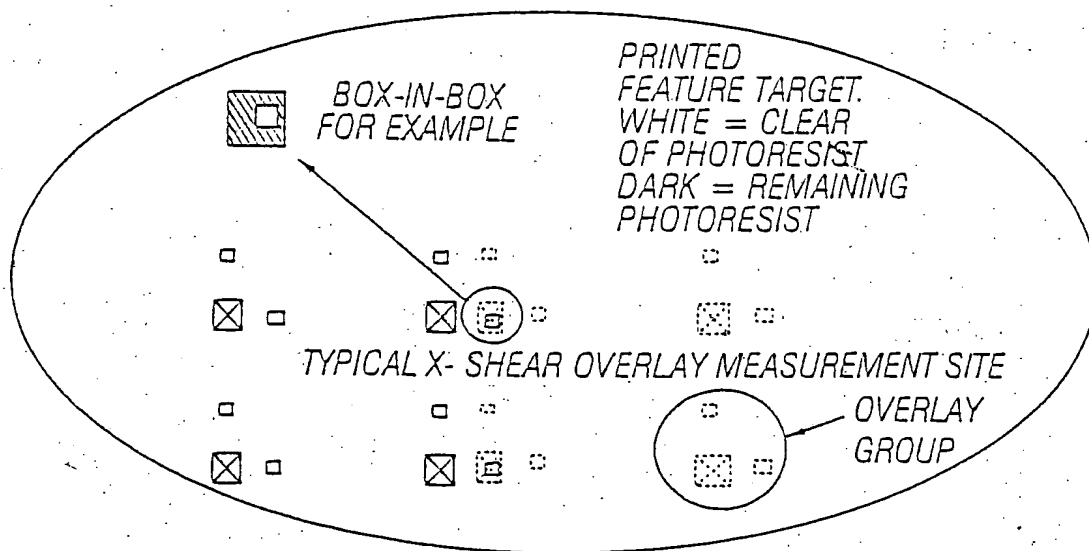


FIG. 35B

*Final results of the method of this invention.
 Units = microns, (xf, yf) = intra-field location,
 (dxf, dyf) = intra-field distortion at point (xf, yf).*

Machine id: DUVF11-02			
xf	yf	dxf	dyf
-10000.000	-10000.000	-0.139	0.044
-8000.000	-10000.000	0.223	-0.233
-6000.000	-10000.000	0.498	0.004
.	.	.	.
10000.000	10000.000	0.099	-0.188

FIG. 36

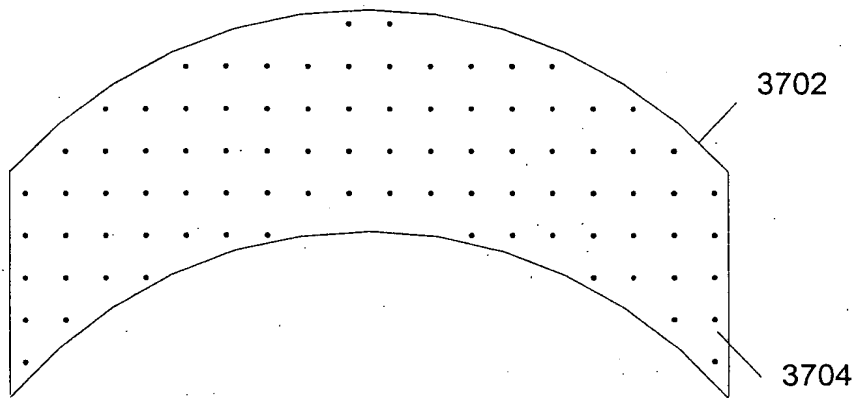


Figure 37



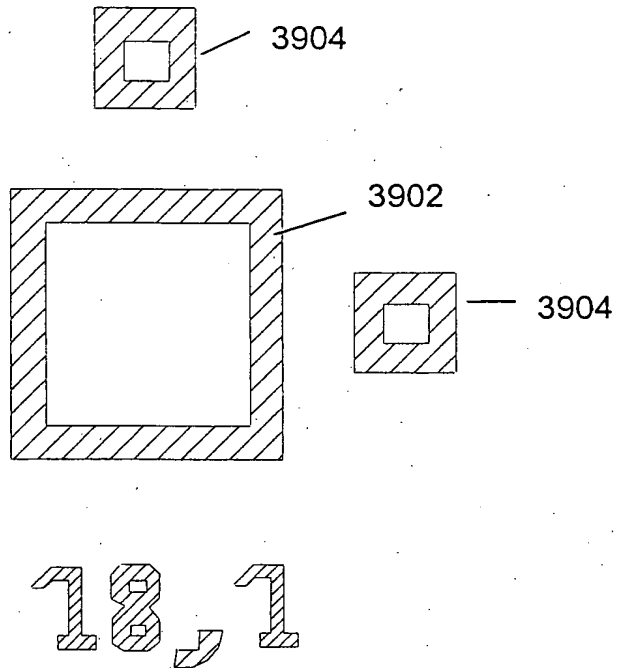


Figure 39

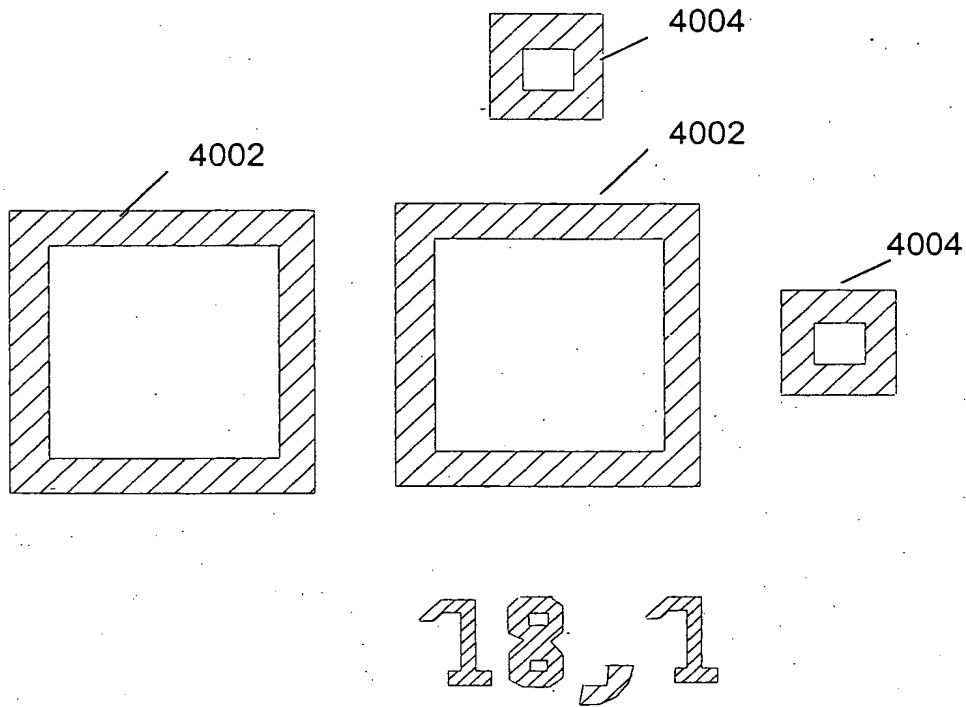


Figure 40

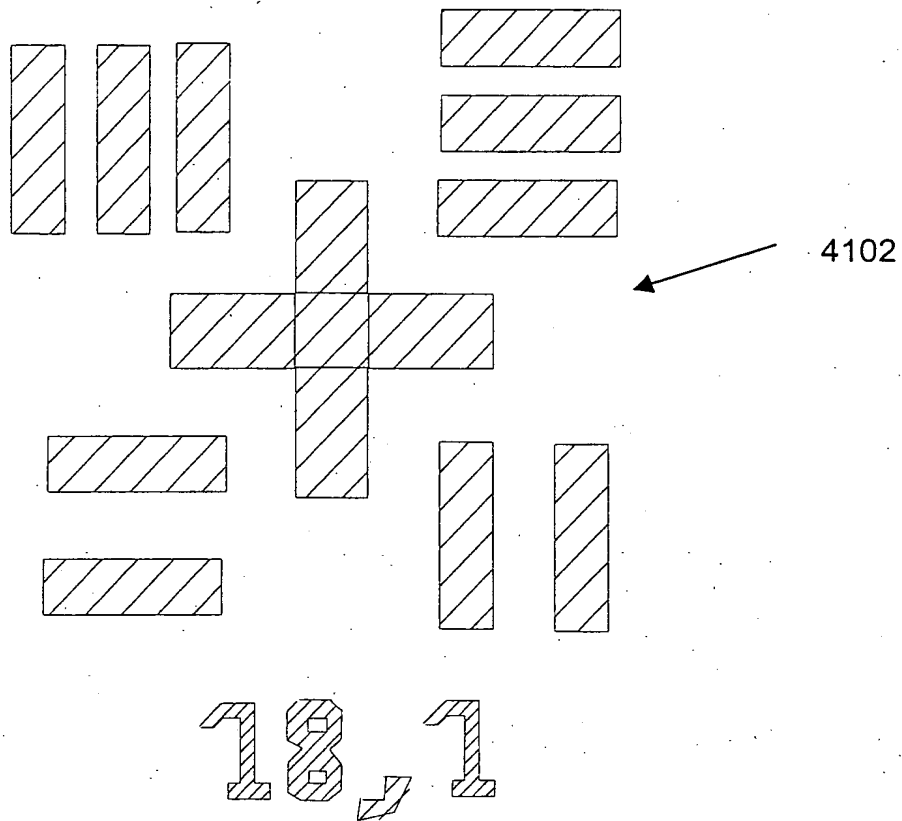


Figure 41

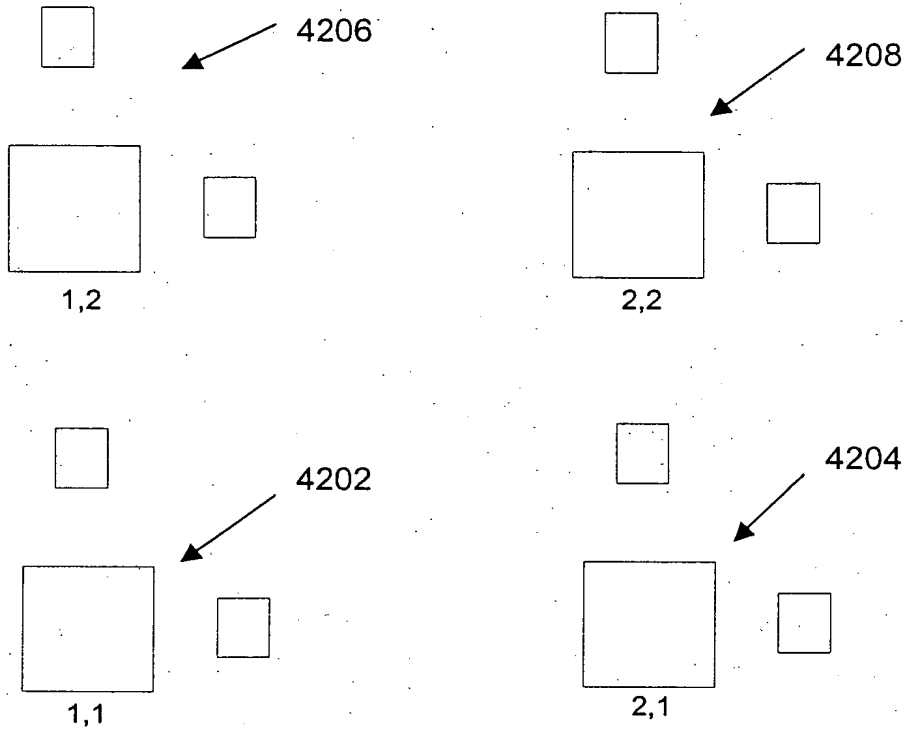


Figure 42

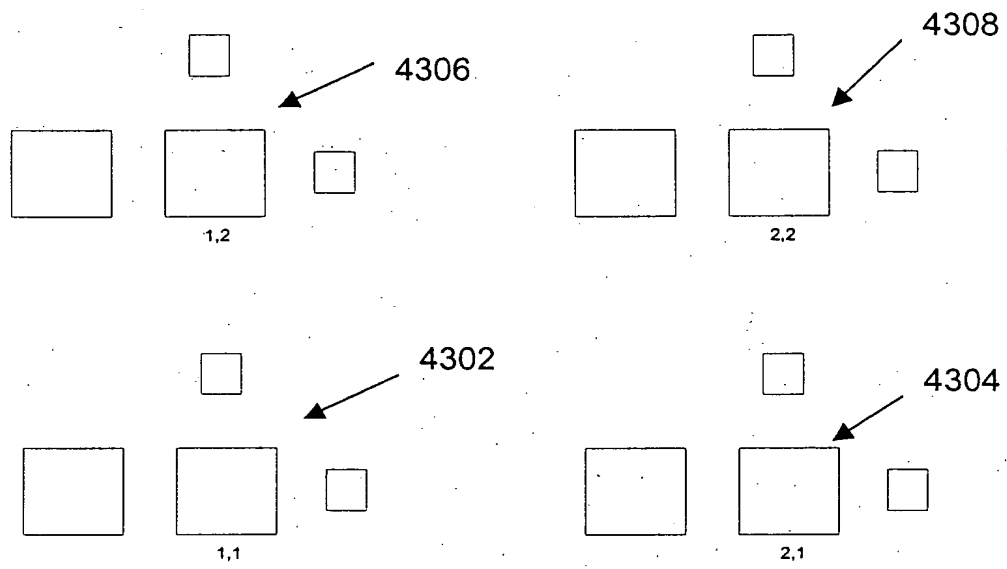


Figure 43

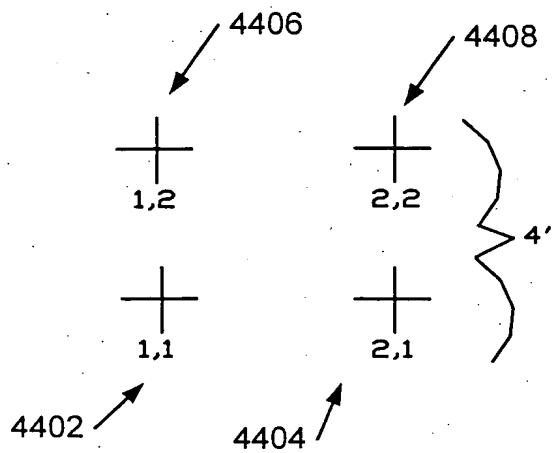


Figure 44

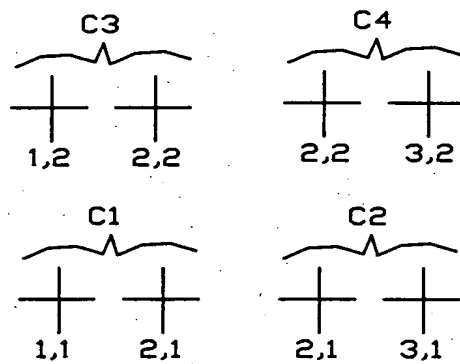


Figure 45

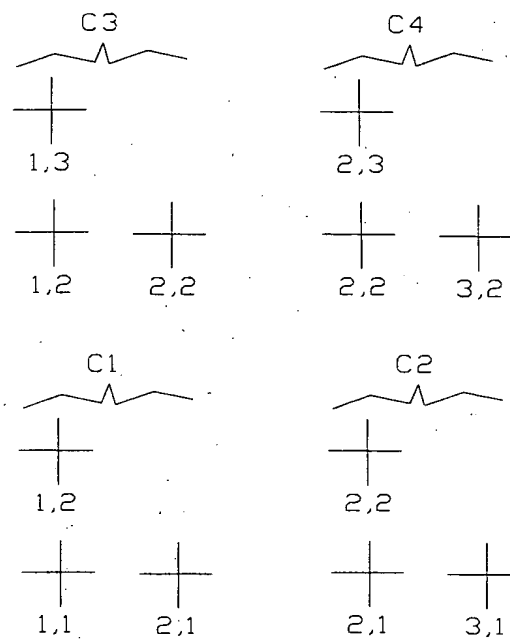


Figure 46

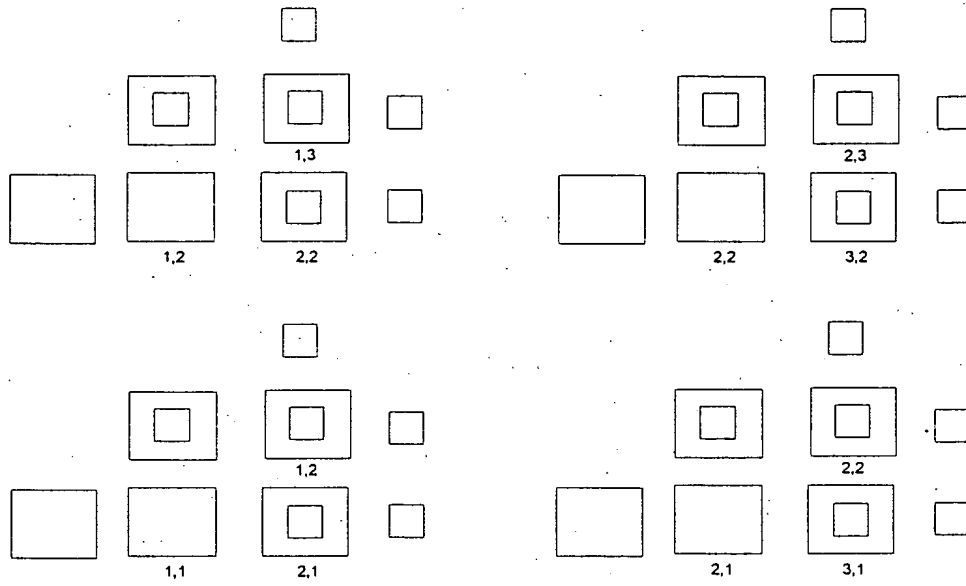


Figure 47

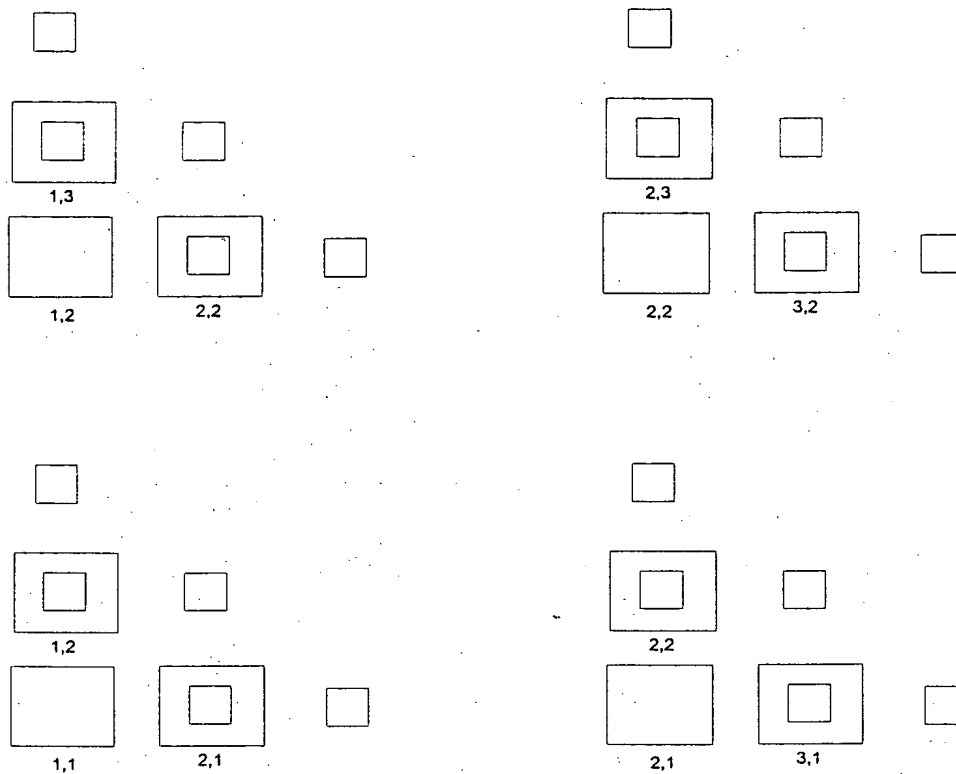


Figure 48

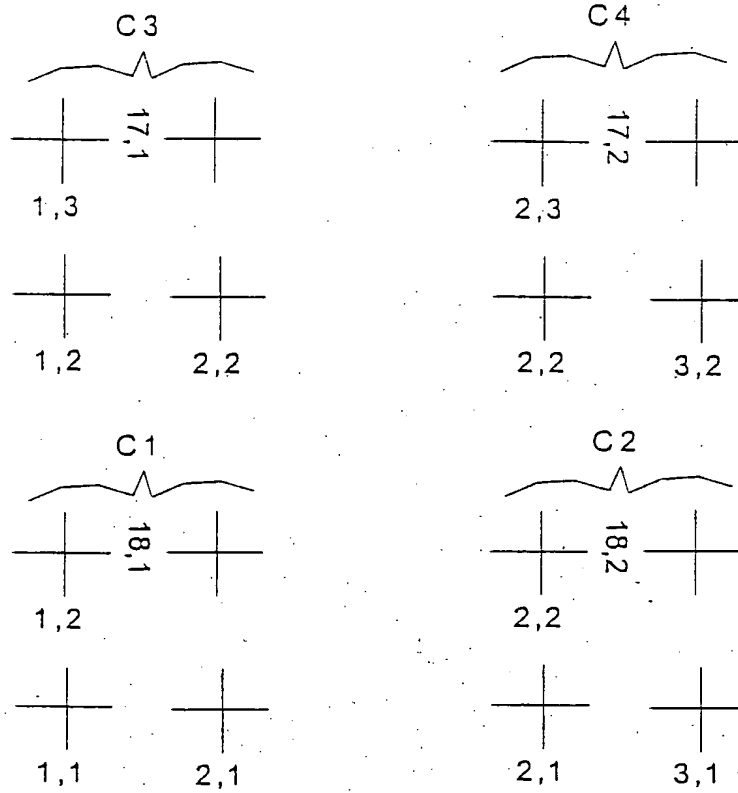


Figure 49

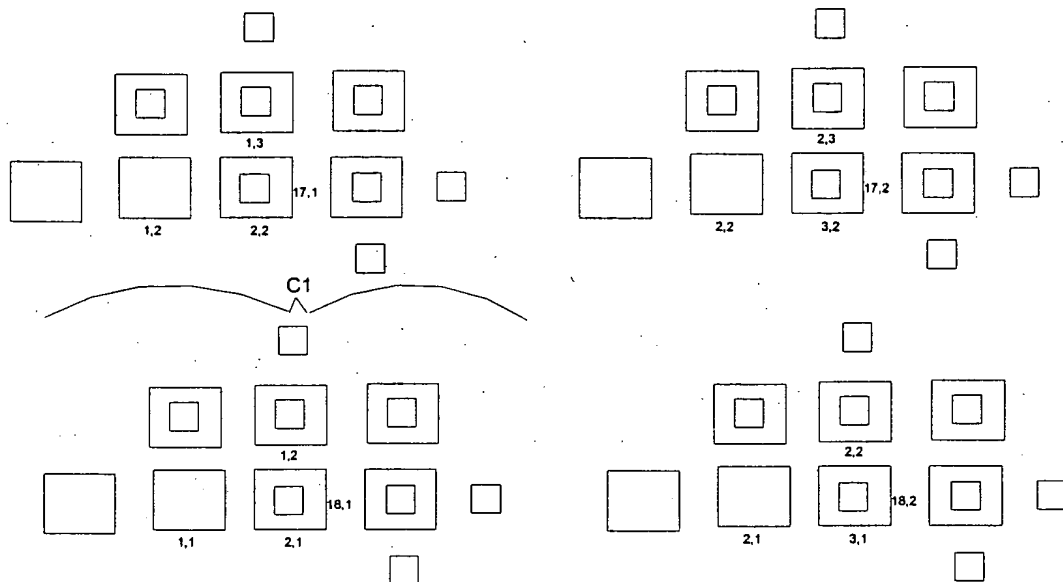


Figure 50

Machine id: DUVF11-03

xf	yf	a2	a3
-10000	-10000	-0.15	0.06
-8000	-10000	-0.17	-0.42
-6000	-10000	-0.38	-0.01
-	-		
-	-		
-	-		
-	-		
-	-		
10000	10000	0.11	-0.08

Figure 51
Final result for computation of x and y tilt.
(xf,yf) = intrafield location in microns
(a2, a3) = (x,y) tilt in radians